

## The truth about structure and bonding

1. Each molecule of sodium chloride contains one sodium ion and one chloride ion. **FALSE:** there are no molecules in sodium chloride, just ions. A molecule comprises a group of atoms covalently bonded together, and only weakly bonded (if at all) to other molecules. In sodium chloride each ion is strongly bonded to each of its six nearest neighbours.
2. Each sodium ion is attracted to one chloride ion. **FALSE:** there is no limit to the number of positive ions that a negative ion can be attracted to (although there is a limit to how many can cluster around it).
3. The ions exist in pairs containing one sodium ion and one chloride ion. **FALSE:** The ions are arranged in a giant lattice. There is no limit to the number of sodium ions that a chloride ion can be attracted to (although there is a limit to how many can cluster around it)
4. In the diagram a chloride ion is attracted to one sodium ion by a bond and is attracted to up to three other sodium ions just by forces. **FALSE:** In the diagram each chloride ion is attracted to up to four sodium ions by a bond that is an electrostatic force. (There would also be a fifth sodium ion above the chlorine ion and one more below - but these are not shown in the diagram.)
5. There is a bond between the ions in each molecule, but no bonds between the molecules. **FALSE:** there are no molecules in sodium chloride, but a continuous network of bonds throughout the lattice.
6. There are no molecules shown in the diagram. **TRUE:** A molecule comprises a group atoms covalently bonded together, and only weakly bonded (if at all) to other molecules. In sodium chloride each ion is strongly bonded to each of its six nearest neighbours.
7. An ionic bond is when one atom donates an electron to another atom. **FALSE:** an ionic bond is the electrostatic force which holds two oppositely charged ions together. The ions could have become charged by electron transfer, but usually the ions were charged long before they came into contact. The bond is no stronger in the few cases where an electron has transferred between two atoms to give the ions that have become bonded.
8. A sodium atom can only form one ionic bond, because it only has one electron in its outer shell. **FALSE:** a sodium ion can strongly bond to as many chloride ions as can effectively pack around it in the regular crystal lattice. In NaCl there will be six chloride ions strongly bonded to each sodium ion.
9. The sodium ions and chloride ions are not joined to each other, but are attracted to each other by electrostatic attraction. **TRUE**
10. Each sodium ion is attracted to all the chloride ions surrounding it. **TRUE**
11. The ions are separated. **TRUE**
12. The sodium chloride molecules break apart when they dissolve. **FALSE:** there are no molecules in sodium chloride, just ions.
13. The sodium and chloride ions move around in  $\text{Na}^+ \text{Cl}^-$  pairs. **FALSE:** the ions move around independently of one another (although they still will be attracted to many other ions of opposite charge).
14. The solution conducts electricity because electrons can pass through the solution. **FALSE:** the solution conducts electricity because the ions are now free to move around and act as charge carriers.
15. Methane is a gas at room temperature because the bonds between the atoms are weak. **FALSE:** methane is a gas at room temperature because it has a low boiling point. The low boiling point arises because of the weak intermolecular forces which operate between the molecules (the strong covalent bonds within the molecule are not affected during changes of state).
16. Ethane has a higher boiling point than methane because there are more bonds to break. **FALSE:** Ethane has a higher boiling point because it has stronger intermolecular forces operating between its molecules. It has stronger IMFs because it has a higher molecular mass.
17. Carbon dioxide has a higher boiling point than methane because its atoms are held together by double bonds rather than single bonds. **FALSE:** Carbon dioxide has a higher boiling point because it has stronger intermolecular forces operating between its molecules. It has stronger IMFs because it has a higher molecular mass.

18. Diamond has a high melting point because the atoms are all joined by covalent bonds in a lattice. **TRUE**
19. Diamond has a high melting point because there are strong covalent bonds between its molecules. **FALSE:** Diamond has a high melting point because there are strong covalent bonds between its atoms.
20. The metal is held together by the attraction between the copper ions. **FALSE:** The metal is held together by the strong forces of attraction between the copper ions and the free moving outer shell electrons.
21. Copper has a high melting point because there are strong forces of attraction between the copper ions and the free moving outer shell electrons. **TRUE**
22. The metal conducts electricity because the copper electrons are free to move. **TRUE/ FALSE:** Remember that not all electrons are involved in conducting electricity; only the free moving outer shell electrons (the delocalized electrons).
23. Copper has a high melting point because there are lots of strong covalent bonds to break. **FALSE:** There are no covalent bonds in metals. Copper has a high melting point because there are strong forces of attraction between the copper ions and the free moving outer shell electrons.
24. Copper can be bent because the layers of copper ions can slide relative to each other. **TRUE.**